

REMARKS

This application has been carefully reviewed in light of the Office Action dated December 23, 2003. Claims 22, 29 and 58 have been amended. Claim 59 has been canceled. Claims 22-35 and 58 are now pending. A Petition for Extension of Time (one-month) is being filed concurrently herewith. Applicant reserves the right to pursue the original claims and other claims in this and other applications. Applicant respectfully requests reconsideration of the above-referenced application in light of the amendments and following remarks.

Applicant's representative conducted telephonic conferences with the Examiner on March 19 and March 22, 2004. In those telephonic conferences, the Examiner indicated that a limitation regarding the thickness of the aluminum nitride layer from approximately 100 Å to approximately 1000 Å, incorporated into the independent claims, may prove sufficient to place the present application in condition for allowance. As the Examiner acknowledged in the telephonic conference, the prior art of record did not teach or suggest an aluminum nitride layer having a thickness of approximately 100 Å to approximately 1000 Å.

In the March 22, 2004 telephonic conference. Applicant's representative indicated to the Examiner that the priority objection the December 23, 2003 Office Action set forth was improper. The present application claims the benefit of U.S. Patent Application No.: 09/547,926 filed on April 11, 2000. The Examiner acknowledged that in the preliminary amendment filed on October 22, 2001, a claim for priority was made. The Examiner stated that a proper claim for priority had been made. The following remarks are made in a more specific response to the Office Action dated December 23, 2003.

The specification is objected to because of an informality. The specification has been amended. In particular, the typographical error on pg. 13, line 8 has been amended to now state, "continuous" rather than "continuos." The Examiner's approval is solicited.

Claims 22-35 and 58-58 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Chiang in view of Moslehi. The rejection is respectfully traversed.

Chiang does not teach or suggest “forming a heat-radiating layer on an upper surface portion of said copper conductor, said heat-radiating layer comprising aluminum nitride passifying said upper surface portion of said copper conductor, wherein said heat-radiating layer is formed from approximately 100 Å to approximately 1000 Å thick,” as recited in claim 22 (emphasis added), or “a heat-radiating layer comprising aluminum nitride . . . wherein said heat-radiating layer is formed from approximately 100 Å to approximately 1000 Å thick” as recited in claim 29 (emphasis added), or “forming a heat-radiating layer . . . said heat-radiating layer comprising a continuous layer of aluminum nitride . . . wherein said heat-radiating layer is formed from approximately 100 Å to approximately 1000 Å thick,” as recited in claim 58 (emphasis added). Chiang does not teach or suggest a heat-radiating layer comprising aluminum nitride that is from approximately 100 Å to 1000 Å thick as recited in claims 22, 29 and 58.

Chiang teaches a “silicon oxynitride passivation layer 80” provided over a portion of a contact plug 61 and a titanium nitride barrier layer 60 on the sidewalls and bottom of the contact plug 61, (Col. 8, lines 10-68, Col. 9, lines 49-50) and that “the copper within the interconnects [contact plug] is encapsulated to prevent copper diffusion into a silicon dioxide layer,” and that “[t]itanium nitride and silicon oxynitride act as diffusion barriers to the copper.” (Col. 10, lines 9-15) (emphasis added).

Moslehi teaches a “free-space ILD/IMD structure . . . [thereby eliminating] the need for the use of diffusion barrier layers to encapsulate the metallization structure at each interconnect level.” (Col. 8, lines 25-31) (emphasis added). Thus, “copper can be deposited directly on the patterned structure without a need for a diffusion barrier layer.” (Col. 12, lines 26-28) (emphasis added).

Significantly, Moslehi does not teach or suggest the use of AlN to prevent the diffusion of copper into a surrounding material, and specifically, does not teach use of AlN to prevent copper from diffusing into silicon dioxide and silicon, which is the very purpose of Chiang's silicon oxynitride passivation layer. The teachings in Moslehi simply do not relate to the problem addressed in Chiang: preventing the diffusion of copper in an interconnect structure.

Moslehi may generally suggest that AlN films have been used as a passivation layer in integrated circuits; however, there is no motivation to use the Moslehi AlN film to passivate the contact plugs of Chiang, where the passivation layers in Chiang act as copper barriers. Applicant disagrees that "[t]he fact that the passivation layer had additional benefits and uses in the Chiang et al. reference is irrelevant." (Office Action, pg. 13). Chiang's silicon oxynitride passivation layer is primarily used as a diffusion barrier. There is no teaching or suggestion in Chiang to use an AlN layer because an AlN layer would not act as a diffusion barrier layer to copper. As a result, there would be no motivation to combine the two references. Although AlN may have properties that are beneficial, there still must be some motivation in either Chiang or Moslehi for the combination. In this case, removing Chiang's silicon oxynitride passivation layer would defeat the purpose taught in Chiang, e.g., preventing copper diffusion into the surrounding silicon layers.

Thus, Applicant respectfully submits that since these two references solve different problems, there is no motivation to combine the references. Chiang is directed to methods of providing a structure that can utilize copper interconnects. Chiang provides a structure that encapsulates copper 61 with barrier layers 60 such that the copper 61 does not diffuse out into the semiconductor device (Col. 2., lines 48-52). Moslehi is directed to providing methods of forming a structure that does not use barrier layers. In fact, Moslehi teaches that "all via-level barrier layers can be eliminated." (Col. 7, lines 48-53). One skilled in the art would not look to Moslehi since it solves a completely different problem than Chiang solves. Again, there must be some motivation to combine the references. See M.P.E.P. § 2143.01.

For at least these reasons, independent claims 22, 29 and 58 are allowable over the cited references. Claim 23-28 depend from claim 22 and are similarly allowable along with claim 22. Claim 30-35 depend from claim 29 and are similarly allowable along with claim 29.

The Office Action further asserts that "Moslehi also discloses the method wherein the aluminum nitride is a thickness of approximately 300 angstroms." Applicant respectfully disagrees.

Moslehi teaches that the aluminum nitride is formed to be "at least a 5000 Å thick layer of insulating material." (See Col. 15, lines 2-15) (emphasis added). The cited reference's aluminum nitride layer is thicker by a factor of at least 15 than Applicant's claimed aluminum nitride layer. Moslehi does not teach an aluminum nitride layer that is approximately 300 Å thick as recited in claims 25 and 32.

As the Examiner acknowledged in the March 19 and March 22, 2004 telephonic conferences, the cited references do not teach or suggest forming a heat-radiating layer that is from approximately 100 Å to approximately 1000 Å thick.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to pass this application to issue.

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Respectfully submitted,

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